Chapter 2

The concept of energy transition

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The concept of transition is naturally associated with innovation and new technologies. For millennia, mankind was developing relatively slowly, until the 17th century satisfying their energy demands mostly with the use of wood (biomass) combustion energy, wind energy, or water energy (water wheel). The 21st century is a time of energy transition defined as a transition from fossil fuels to zero emission or low emission energy sources. Sustainable development, which results in the formation of sustainable economies, will in the long run lead to considerable, and in some cases even complete, replacement of coal, oil, and natural gas with renewable energy sources (RES) in the energy mix, both in terms of individual countries and the global structure of energy consumption. Energy production from renewable energy sources is one of the most prospective foundations of ecology and energy modernization.[27] It is especially evident in the European Union. According to data from EWEA, in 2015 the greatest power increase

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[27] T. Młynarski, M. Tarnawski, *Źródła energii i ich znaczenie dla bezpieczeństwa energetycznego w XXI wieku [Energy sources and their importance for energy security in the 21st century],* Difin, 2016, pp. 223-226.

occurred in wind power plants (12,800 MW, which was 44.2% of the total increase of new power in the EU) and power plants using solar energy (8,500 MW, accounting for 29.4%). These two energy technologies are also going to dominate in the near future. Analyzing the scale of increase of generating capacities of wind power plants in 2015, the highest increase was traditionally observed in Germany: 6,013 MW. Germany is the country with the highest generating capacity of wind power plants in the EU and it is followed by Poland with 1,266 MW.[28]

Definitions of energy transition

A narrow definition of energy transition is: change from the current energy system using non-renewable energy sources (fossil fuels) to an energy system mostly based on renewable sources. Therefore, it is an important element of the ecological approach in the energy industry, involving gradual replacement of exhaustible hydrocarbons and uranium fuel with RES in almost all areas of human activity (transport, industry, energy sector, heating, etc.). Factors that promote the development of renewable energy are technological advancement, growing competition, and an appropriate policy of support, especially in countries such as the USA, India or China. Besides, more and more countries intend to develop renewable energy so as to reduce the impact of the traditional energy sector on the environment, diversify energy supplies, and enhance their own energy independence.[29]

In a broader sense, energy transition is identified as the popularization of low-emission energy sources on the basis of low-emission and effective (energy saving) technologies of energy production. One element of energy transition is the development of the idea of energy saving, which means an improvement in energy efficiency in different sectors of industry and services (i.e., insulation and thermomodernization, energy-saving lighting, cogeneration – generating heat and energy at the same time and energy recovery in industrial processes).

Research carried out by Ludger Gailing and Timothy Moss shows that energy transition applies to four aspects: institutional change,

[28] *Wind in Power: 2015 European statistics,* EWEA, 2016; www.ewea.org

[29] *The Medium-Term Renewables Market Report, Market Analysis and Forecasts to 2021,* International Energy Agency, Paris 2016.

material aspect, power and space.[30] In the first aspect, energy transition means the need of institutional collaboration leading to better understanding of the social context of energy transition and the development of a relevant strategy.[31] The second, material aspect leads to the conclusions that energy may not only be generated from fossil fuels or RES, but also e.g. from waste processing (waste to energy) or improving energy efficiency.[32] The third plane, referring to power, shows that different actors clash at the local and regional level, often representing different interests connected with energy projects that follow the concept of energy transition.[33] The fourth aspect, related to space, highlights that local, regional and national spatial planning plays a significant role in the process of energy transition, as it is directly related to the location of new investments.[34]

Energy transition vs sustainable development

The concept of energy transition is also connected with sustainable development, which can be defined in two ways: as a process of development (e.g. of countries) that unconditionally combines the needs of today's generation with the ability to satisfy the needs of future generations.[35] The other definition of sustainable development is: a chain of changes in which the use of resources, the structure of investments, as

[30] L. Gailing, T. Moss, *Conceptualizing Germany's Energy Transition*, Palgrave Macmillian, London 2016, pp. 4-7.

[31] S. Becker, R. Beveridge, A. Röhring, *Energy Transition and Institutional Change: Between Structure and Agency* [in:] L. Gailing, T. Moss, *Conceptualizing Germany's Energy Transition*, Palgrave Macmillian, London 2016.

[32] T. Moss, S. Becker, L. Gailing, *Energy Transitions and Materiality: Between Dispositives, Assemblages and Metabolisms* [in:] L. Gailing, T. Moss, L. Gailing, T. Moss, *Conceptualizing Germany's Energy Transition*, Palgrave Macmillian, London 2016.

[33] A. Bues, L. Gailing, *Energy Transitions and Power: Between Governmentality and Depoliticization* [in:] L. Gailing, T. Moss, *Conceptualizing Germany's Energy Transition*, Palgrave Macmillian, London 2016.

[34] S. Becker, T. Moss, M. Naumann, *The Importance of Space: Towards a Social-Material and Political Geography of Energy Transition* [in:] L. Gailing, T. Moss, *Conceptualizing Germany's Energy Transition*, Palgrave Macmillian, London 2016.

[35] W. Sztumski, *Idea zrównoważonego rozwoju a możliwości jej urzeczywistnienia [The idea of sustainable development vs the possibility of its implementation],* Problemy Ekorozwoju, vol.1, 2006, p. 73.

well as the direction of technological advancement and institutional structures must prevent discrepancies between present and future needs.[36] The idea of sustainable development is mentioned in several national and international legal or political documents. In Poland, it is referred to in Article 5 of the Constitution of the Republic of Poland.[37]

Energy efficiency and renewable energy are regarded as twin pillars of sustainable energy policy. Ecological modernization of the economy through technological innovations is to ensure progress in the achievement of environmental goals and industrial progress (sustainable development).[38] Energy transition – not only the transition of the energy sector – is centralized, proportional to the development of an international regime of counteracting climate change, and is based on radical changes in energy policy, i.e. transformation from centralized to decentralized and prosumer production (dispersed production installation). It is worth emphasising that low and very low capacity units (so-called mini and micro cogeneration) have recently appeared on the market. They are characterized i.a. by simple installation and short time of investment performance. These characteristics, as well as the module character of the devices, make them an attractive alternative to large energy producers.[39] Thus, it is ecology-energy transition, which allows the separation of economic growth from pollution emission. In social sciences related to energy, scientific debate is going on concerning energy transition.[40] It is emphasized that thinking in the categories of "transition" leads to understanding how new and inno-

[36] Report from the UN World Commission on Environment and Development (WCED), 1987.

[37] A. Pultowicz, *Przesłanki rozwoju rynku odnawialnych źródeł energii w Polsce w świetle idei zrównoważonego rozwoju [Reasons for the development of renewable energy sources market in Poland in the light of the ides of sustainable development]*, Problemy Ekorozwoju – Problems Of Sustainable Development, vol. 4, No 1, 2009, pp. 109-115.

[38] Cf.: L. van Schaik, S. Schunz, *Explaining EU Activism and Impact in Global Climate Politics: Is the Union a Norm- or Interest-Driven Actor?*, JCMS, Journal of Common Market Studies , 2012, Vol. 50. No. 1, p. 178.

[39] E. Mokrzycki (ed.), *Rozproszone zasoby energii w systemie elektroenergetycznym [Dispersed energy resources in electricity system],* Wyd. Instytutu Gospodarki Surowcami Mineralnymi i Energią Polskiej Akademii Nauk, Kraków 2011, pp. 7-8.

[40] S. Strunz, *The German Energy Transition as a Regime Shift*, "Ecological Economics" no. 100, pp. 150-158.

vative technologies can develop a more sustainable society. According to Robert B. Laughlin, in the future, people will prefer to live with clean air, water and natural environment.[41] This means that energy transition should take into account the needs of civil society in terms of reducing the negative influence of the energy sector on the natural environment. This is especially important given that the energy sector is the main source of greenhouse gases emission. In Poland, energy transition is associated with the hope for lower emissions of different air pollutants, because according to the report of the European Environment Agency of 2016, the level of air pollution in Poland is very high (Poland is second in terms of the concentration of particulate matter PM_{10} in the air, and first in terms of benzo[a]pyrene).[42] The report of the Supreme Chamber of Control of 2014 also confirms that Poland has the most polluted air out of all EU countries.[43]

Energy transition as a lever for economic development

Energy transition understood as conversion towards a sustainable development economy does not only promote environmental protection, but also – in the long run – will enhance the competitiveness of the economy, providing thousands of jobs and improving people's quality of life. Modernization of energy industry gives an advantage to regional and global regimes of CO_2 emissions reduction based on modern, low-emission energy technologies. Energy transition will support the development of industry and employment, attract investments for sustainable, innovative and low emission technologies, which improves the competitiveness of industry. Adapting the energy sector to climate change is becoming a catalyst for the modernization of economies (new branches of the economy are emerging, which stimulate employment). Energy transition is a great opportunity to promote economic

[41] R. B. Laughlin, *Powering the Future*, Basic Books, New York 2011, p. 5.

[42] *Air quality in Europe — 2016 report,* European Environment Agency, Copenhagen, Denmark, 2016, pp. 29-48.

[43] *Informacja o wynikach kontroli: ochrona powietrza przed zanieczyszczeniami [Information on the outcome of control of air pollution protection],* Najwyższa Izba Kontroli, Warsaw 2014.

interests based on stimulating economies through the establishment of new eco-jobs and the export of low carbon emission technologies. Increasing the share of alternative energy sources in the total energy balance of a country and improving energy efficiency does not only help improve energy security, but also gives some economic benefits through ensuring competitive advantage connected with the use and export of modern energy technologies reducing GHG emission. In the future, the potentially significant rise in the price of the right to emit greenhouse gases will enforce even greater profitability of preferred technologies supporting low emission economies. Energy transition thus means the formation of a more competitive low emission economy; environmental protection including the reduction of greenhouse gases and the prevention of biodiversity loss; the implementation of new, climate-friendly technologies of energy production and intelligent networks for its transmission (*Smart Grid*); and educating consumers The effect is economic stimulation, creating new jobs, and promotion of the development of local communities. Therefore, energy transition links economic growth and respect for the natural environment by reducing the growth of energy demand, by developing competitive renewable energy sources and other low emission energy carriers, in particular alternative fuels used in transport, and by improving competitiveness connected with the production of clean energy and rational energy use (efficiency based on innovative technologies). Thus, it integrates three goals: improvement of energy security (stability of supply from domestic energy sources), development of new branches of a "green economy" (increase in competitiveness and GDP), and eco-technological modernization of energy production processes (eco-jobs). This way, environmental goals are connected with economic goals, and the policy of ecological energy transition achieves economic goals.[44]

It is commonly assumed that new technologies lead to reducing energy dependence on fossil energy resources through more effective use of or departure from such resources in favor of the development of renewable energy based on natural use of sunlight, wind energy, river course and geothermal energy. We also need to remember energy

[44] T. Młynarski, M. Tarnawski, *Źródła energii i ich znaczenie [Energy sources and their importance]... op. cit.*, p. 203.

technologies that allow the combustion of fossil fuels in an environmentally clean way. Whereas the dynamic growth of importance in RES in the energy balances of different countries, regions, or the world, is certainly true, we need to remember that about 77% of electricity globally is produced from fossil fuels. In the case of Poland, because of its having substantial (with regard to Europe) resources of hard coal and lignite, the share of those fuels in electricity production in 2015 was 86% and was one of the highest in the world. Therefore, *CCT (Clean Coal Technologies)* are expected to be the main direction of development towards clean energy technologies in Poland. We should remember that clean energy technologies using fossil fuels are related to high investment expenditure and higher operating costs than technologies used currently. Among other things, this is due to the costs of installation of *CCS (Carbon Capture and Storage)*. With the current assumptions of EU energy policy, it seems that apart from economic factors, ecological aspects will also play an important role in making decisions on the choice of technology of electricity production.[45] The significance of ecological aspects is proved, not only by EU regulations, but also by the provisions of the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change, which took place in December 2015 in Paris. The Paris Agreement was signed by Poland on April 27, 2016, in the UN headquarters in New York. Accepting the agreement will be connected with efforts to reduce CO_2 emissions. But it should be stressed that the way of achieving this goal is determined by each country independently.[46]

However, the crucial issue in achieving the goals of the agreement is probably the change in the energy sector, which is the main source (at least 2/3) of greenhouse gases emission.[47] It is important to see the variety of locations of fossil energy resources, as well as geographical potential enabling their use in renewable energy industry. Taking

[45] D. Kryzia, L. Gawlik, M. Pepłowska, *Uwarunkowania rozwoju czystych technologii wytwarzania energii z paliw kopalnych [Determinants of the development of clean technologies of energy production from fossil fuels]*, Polityka Energetyczna – Energy Policy Journal, vol. 19, part 4, 2016, pp. 63-74.

[46] B. Zaporowski, *Zrównoważony rozwój źródeł wytwórczych energii elektryczne [Sustainable development of electricity production sources],* Polityka Energetyczna – Energy Policy Journal, vol. 19, part 3, 2016, pp. 35-48.

[47] World Energy Outlook 2016, International Energy Agency, Paris 2016, p. 35.

into account the fact that the energy balance structure is different in each country, the process of energy transition in the countries will also differ. This results from the fact that globally the governments of each country have retained the greatest rights to shape national energy policies. The situation is the same at the EU level, because Article 4 section 2 of the Treaty on the Functioning of the European Union (TFEU) provides that competencies in the area of energy are shared between member states and EU institutions.[48] The diversity of energy transition in different countries not only refers to the potential connected with geographical conditions and resource potential, but also to the diversity of R&D specialization in each economy. Doubtless, climate policy, which has become the catalyst for implementing new technologies in the energy sector, will have a significant impact on energy transition processes, but global energy infrastructure should be strengthened in parallel with this process. Currently, it is evident that in many countries considerable investments in new capacities of renewable energy do not correspond to the speed of development of investments in electricity infrastructure. Broad application of renewable energy requires the stabilization of electricity networks ensured currently by conventional energy. This means that appropriate spatial planning is necessary, even more so because the process of energy transition increasingly applies to the transport sector, which is one of the most high emission sectors of economy. The process of modernization of the energy sector should strengthen sustainable transport through the development of global electromobility. Energy transition and the increase in importance of RES in the energy balances of each country are closely connected with the problem of energy storage. Recently, energy storage technologies (e.g., power-to-gas) have been developing, which enables the conversion of energy surplus to a form of energy that is easier to store and transport (e.g., hydrogen). The consequence of these activities will be a gradual reduction in countries' oil import dependency and greater use of electricity in the automotive industry. Globally, this will allow many economies to save some

[48] *Treaty on the Functioning of the European Union* (consolidated text, OJ EU C 326/47.
G. Moens, J. Trone, *The political institutions of the European Union,* "Commercial Law of the European Union", Springer, Netherlands, 2010, pp. 26–27.

financial resources, which – if they are used properly – may become a source of financing new investments, improving energy efficiency and optimum use of energy resources even more.[49] A similar process can occur in the area of construction, where modern materials are now used which allow the construction of energy-saving passive houses. We need to stress that innovation resulting from energy transition also involves a change of tendencies and a departure from old business models in favor of decentralized ones, and the formation of local energy clusters combining different technologies and aiming at synergy between them.[50] For this reason, energy transition is not only technological innovation, but also regulatory innovation of the energy sector on the global scale.[51] The process of energy transition will not only lead to protecting the natural environment, but first of all, to creating new jobs and enhancing energy security.[52]

Analyzing data of the International Energy Agency of 2015, we may conclude that energy transition is already a fact. The upward tendency of CO_2 emissions related to the energy sector came to a halt in 2015, mostly as a result of lowering the energy intensity of the global economy by 1.8%, connected with accomplishments in energy efficiency and higher use of low emission energy sources all over the world, especially renewable energy sources. Maintaining the decrease of GHG emissions in the following years will enable countries to meet their climate obligations as part of the Paris Agreement. Recently, the drop in oil and natural gas extraction investments (the highest within nearly seventy years) has been accompanied by growth in investments in the sector of clean energy technologies by approximately 1.8 trillion USD

[49] "In 2012 Poland imported almost 25 million tonnes of oil, of which 95 percent came from Russia, for over 15 billion euro". See L. Jesień, M. Kurtyka, *New Electricity and New Cars. The Future of the European Energy Doctrine*, CeDeWu, Warsaw 2016, p. 118.

[50] M. Kurtyka, presentation at the National Scientific Conference "Polityka energetyczna UE - filary i perspektywa rozwoju" *[EU energy policy: foundations and prospects of development]*, Rzeszów 25-26.04.2016.

[51] K. Steinbacher, M. Pahle, *Leadership by Diffusion and the German Energiewende.*, "SSRN Electronic Journal", 2015, http://doi.org/10.2139/ssrn.2565313

[52] D. Tänzler, S. Wolters, S., *Energiewende und Außenpolitik: Gestaltungsmacht auf dem Prüfstand*, "Zeitschrift für Außen- und Sicherheitspolitik", no. *7*(2), 2014, pp. 133–143.

a year. On the other hand, the value of subsidies for the consumption of fossil fuels fell to 325 billion USD in 2015 from almost 500 billion in 2014. This significant reduction is the result of lower prices of fossil fuels and reforms of fuel subsidizing in many countries.[53]

Data from the market of renewable energy also proves energy transition. Globally, in 2015, RES installations accounted for more than half of new generating capacities (153 GW, i.e., 15% more than in 2014, including 63 GW more in wind energy and 49 more in solar energy). The IEA estimates that within five years, RES will be the quickest developing source of electricity, and their share will grow up to 28% in 2021. In 2015, the share of RES was 23%. The IEA forecasts that in 2021 the costs of technology will be reduced by 25% in photovoltaics and by 15% in land wind energy.[54]

Energy transition is also a comprehensive change in the way of thinking about and perception of the energy sector. The perception of the process with reference to the energy sector should be interpreted much more broadly than merely the replacement of fossil fuels with renewable energy.

[53] World Energy Outlook 2016, International Energy Agency, Paris 2016.

[54] *The Medium-Term Renewables Market Report, Market Analysis and Forecasts to 2021,* International Energy Agency, Paris 2016.